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MULTI-LAYER READING DEVICE

REFERENCE TO EARLIER FILED PROVISIONAL APPLICATIONS

This patent application claims the benefit of
priority from, and incorporates by reference the entire
5 disclosure of, co-pending U.S. Provisional Patent
Application Serial Nos. 60/182,742, filed on February 16,
2000, 60/190,343, filed on March 16, 2000, and 60/192,662,
filed on March 28, 2000.

CROSS REFERENCE TO RELATED APPLICATION

10 ~~The present application for patent is related to and
hereby incorporates by reference the subject matter~~

~~disclosed in U.S. Patent Application Serial Nos.~~

_____ (Attorney Docket No. 34650-566PT),
entitled "Specially Formatted Paper Based Applications of
a Mobile Phone"; _____ (Attorney Docket

5 No. 34650-569PT), entitled "Method and System for Using an
Electronic Reading Device as a General Application Input
and Navigation Interface"; _____ (Attorney

Docket No. 34650-578PT), entitled "Predefined Electronic
Pen Applications in Specially Formatted Paper";

10 _____ (Attorney Docket No. 34650-579PT),
entitled "A System and Method for Operating an Electronic
Reading Device User Interface"; _____

(Attorney Docket No. 34650-601PT), entitled "Method and
System for Using an Electronic Reading Device on Non-paper

15 Devices"; _____ (Attorney Docket No. 34650-
604PT), entitled, "Method and System for Configuring and
Unlocking an Electronic Reading Device"; _____

(Attorney Docket No. 34650-606PT), entitled "Printer Pen";

_____ (Attorney Docket No. 34650-607PT),

20 entitled "Method and System for Electronically Recording
Transactions and Performing Security Function";

_____ (Attorney Docket No. 34650-608PT)

entitled "Electronic Pen with Ink On/ink off Function and

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Paper Touch Sensing"; _____ (Attorney Docket
No. 34650-654PT), entitled "Method and System for Handling
FIFO and Position Data in Connection with an Electronic
Reading Device"; _____ (Attorney Docket No.
5 34650-655PT), entitled "Hyperlink Applications for an
Electronic Reading Device"; _____ (Attorney
Docket No. 34650-656PT), entitled "Measuring Applications
for an Electronic Reading Device"; _____
(Attorney Docket No. 34650-657PT), entitled "Method and
10 System for Controlling an Electronic Utility Device Using
an Electronic Reading Device"; and _____
(Attorney Docket No. 34650-658PT), entitled "Positioning
Applications for an Electronic Reading Device"; and
_____ (Attorney Docket No. 34650-673PT),
15 entitled "Method for Sharing Information Between
Electronic Reading Devices"; and in U.S. Provisional
Patent Application Serial Nos. _____
(Attorney Docket No. 34650-671PL), entitled "Electronic Pen
for E-Commerce Implementations"; and _____
20 (Attorney Docket No. 34650-672PL), entitled "Electronic Pen
Help Feedback and Information Retrieval"; all filed
concurrently herewith.

BACKGROUND OF THE INVENTION

Technical Field of the Invention

The present invention relates in general to the communications field, and in particular to an interaction
5 of an electronic reading device with an address pattern.

Description of Related Art

Numerous devices exist for accepting user input and controlling user interaction with desktop and portable computers, personal digital assistance (PDAs), mobile
10 phones, and other types of electronic devices. For example, a keyboard can be used to accept typed input and other types of commands, a mouse or a track-ball can be used to provide relative motion input as well as various types of point-and-click selections, a keypad can be used
15 to provide input of numerical data and functional commands, navigational keys can be used for scrolling lists or otherwise repositioning a cursor, and various types of touchpads or touchscreens can be used to provide absolute positional coordinate inputs. Each type of
20 mechanism for accepting input and for supporting user interaction has benefits and disadvantages in terms of size, convenience, flexibility, responsiveness, and easy

of use. Generally, the selection of a particular type of input mechanism is dependent upon the function of the application and the degree and type of interaction required.

5 With the ever expanding capabilities and availability of applications both on the Internet and the area of wireless technology, there continues to be a need to develop and provide new mechanisms for accepting input and interacting with users. In particular, some of the
10 existing technologies suffer from drawbacks or limitations, such as size and flexibility, that make them impractical and/or inconvenient to use in some situations. By expanding the range of mechanisms for supporting user interaction, application developers and end-users can have
15 greater flexibility in the selection of input devices. Preferably, any such new mechanisms will provide increased flexibility and will maximize user convenience. In addition, the development of new mechanisms for
20 interacting with users can expand the realm of potential applications.

For example, while a keyboard typically provides a great deal of flexibility, particularly when it is used in connection with a mouse, a touchscreen, or other

navigational device, its size makes it inconvenient in many cases, especially in the wireless context.

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5 Mechanisms also exist for inputting or scanning text, images, or other information printed on a sheet of paper and storing the scanned information in an electronic device. Desktop scanners, for example, perform such a function, but are relatively large and are not portable. Although hand scanners also exist, they have to be moved over the printed information in a clearly specified way
10 (e.g., normally in one uninterrupted straight line movement). In addition, each scan performed with the hand scanner is independent from any previous or subsequent scans, making it difficult or impossible to assemble several scans into a complete image. Thus, a hand scanner
15 can be inconvenient and difficult to use.

SUMMARY OF THE INVENTION

The present invention comprises a method and system for scanning information printed on a surface using an electronic reading device, such as a hand scanner. The
20 surface can comprise, for example, a sheet of paper or a display screen. The surface includes both printed information, such as an image or text, and an address

pattern, such as a pattern of dots. The address pattern is formatted such that a position of the electronic reading device relative to the address pattern can be determined by examining only a small portion of the address pattern at and around the particular position.

By scanning the electronic reading device across the surface, portions of the printed information can be detected using a reading sensor on the electronic reading device. At approximately the same time as each detection of a portion of the printed information is performed, an associated portion of the address pattern is also detected. A processor can subsequently reconstruct an electronic copy of the printed information by positioning the detected portions of the printed information according to their associated portions of the address pattern.

Preferably, the printed information and the address pattern are printed or otherwise depicted using two different colors within one or more of the visible light spectrum, the ultraviolet spectrum, and the infrared spectrum. By performing the detection in a way that allows the reading sensor to distinguish between the different colors, the electronic reading device can also

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distinguish the printed information from the address pattern.

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In one embodiment of the invention, the reading device includes a plurality of sensors. At least one of the sensors includes a filter for filtering out parts of the light spectrum reflected by either a layer that includes the printed information or a layer that includes the address pattern. Accordingly, sensors that include the filter are used to detect one of the layers while sensors that do not include the filter are used to detect the other of the layers. To facilitate this detection, the electronic reading device can also include a light emitter for illuminating the surface with a broad spectrum light.

15 In another embodiment, the electronic reading device includes two light emitting diodes (LEDs), one of which emits infrared light and the other of which emits non-infrared light. By alternately activating the LEDs, the reading sensor can alternately detect the printed

20 information and the address pattern.

BRIEF DESCRIPTION OF THE DRAWINGS

For a more complete understanding of the present invention, reference is made to the following detailed description taken in conjunction with the accompanying
5 drawings wherein:

FIGURE 1 is a block diagram of a system in which an electronic pen can be used as an input device;

FIGURE 2 is a schematic diagram of a system for supporting use of the electronic pen described in
10 connection with FIGURE 1;

FIGURE 3 is an illustration of the protocol stacks that can be used in the case of local communications between an electronic pen and an electronic pen client;

FIGURE 4 is an illustration of protocol stacks that
15 can be used when an electronic pen and an electronic pen client communicate with one another via an Internet connection;

FIGURE 5 is an illustration of a protocol stack for communications between an electronic pen client and each
20 of the supporting entities when the electronic pen client is not located within a server on the Internet;

FIGURE 6 is an illustration of protocol stacks that are used for communications between an electronic pen

client and each of the supporting entities when the
electronic pen client is located on the Internet;

FIGURE 7 is a block diagram of the electronic pen
logic that handles positions, strokes, actions, and grid
5 descriptions;

FIGURE 8 is a block diagram of a state machine for
the electronic pen control block shown in FIGURE 7;

FIGURE 9 is a block diagram of a state machine for an
electronic pen client;

FIGURES 10A-10C are a message flow and signaling
10 diagram illustrating the operation of the electronic pen
system shown and discussed in connection with FIGURE 2;
and

FIGURE 11 is an illustration of a preferred
15 embodiment of an electronic hand scanner for scanning
printed information in accordance with the present
invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to a system in which an
20 electronic reading device, such as an electronic pen, an
electronic mouse, or a hand scanner, works in cooperation
with an address pattern (e.g., a specially formatted

paper) to provide for a detection of a location of the electronic reading device over the address pattern. For instance, a pattern of dots can be defined such that, by examining a very small portion of the pattern, a precise location in the overall pattern can be determined. In fact, it is possible to define a pattern that has the size of 73,000,000,000,000 A4 pages, which is equivalent to half the size of the entire United States. Portions of the pattern can be placed on sheets of paper or other objects.

Then, using an electronic scanner pen that can detect the dots in the pattern, it is possible to detect the location of the pen with respect to the unique pattern. For example, when such a pen is used in connection with a specially formatted paper, the pen can detect its position (e.g., using a built in camera) by detecting a 3 mm by 3 mm portion of the pattern. By taking approximately 100 pictures per second, the pen is capable of determining its exact position to within 0.1 mm or less. This system can be used to provide user input, to facilitate user interaction, or to store handwritten notes or drawings. Moreover, by associating portions of the overall pattern with certain applications, such a system can be used to interact with wide variety of applications.

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Referring now to FIGURE 1, there is illustrated an example of a system 2 in which an electronic pen 10 can be used as an input device. The electronic pen 10 includes an ink cartridge and is capable of writing in a typical fashion. The electronic pen 10, however, includes some type of sensor (e.g., a built-in camera) that is used for detecting an address pattern on a specially formatted piece of paper 12. In particular, the paper 12 is formatted with a small portion of a large address pattern such that when the electronic pen 10 is used to write on or otherwise make marks on the paper 12, the writings or markings can be electronically detected and stored.

As an example, the paper 12 might constitute a form that can be used for sending an email. Thus, the paper 12 might include a space for writing in the email address of an intended recipient, a space for writing a subject of the email, and a space for writing the body of the email. As the electronic pen 10 is used to fill in each of the spaces, the position and movement of the electronic pen 10 on the paper 12 can be determined by repeatedly detecting the current x, y coordinates of the pen 10 (e.g., at rate of 100 frames per second). The markings can then be converted into ASCII text using an appropriate handwriting

recognition program. Once the user completes the form, the email can be sent, for example, by checking a send box at a predetermined location on the paper 12.

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Preferably, the coordinate information collected by the pen 10 is sent by a short range radio transmitter in the electronic pen 10 to a nearby mobile station 14 using a short range radio interface 16 such as a local wireless radio link (e.g., a local wireless radio link supported by Ericsson's Bluetooth™ wireless communications technology). Alternatively, instead of using a mobile station 14, the coordinate information could also be sent to, for instance, a desktop or portable computer, a personal digital assistant (PDA), a television, or a Bluetooth terminal. Moreover, instead of using a local wireless radio link, other types of local wireless links, such as inductive coupling and infrared light; other types of radio links, such as Global System for Mobile Communication (GSM); or wired transmission media, such as a cable can also be used. The information can then be forwarded via an appropriate link, such as a cellular air interface 18, to a base station 20 or other network node.

Referring now to FIGURE 2, there is illustrated a schematic diagram of a system 2 for supporting use of the

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electronic pen 10 described in connection with FIGURE 1.
Throughout the subsequent discussion, the system 2 is
described primarily in connection with an electronic pen
10. It will be understood, however, that the invention
5 and the underlying system 2 can instead use any type of
electronic reading device, such as an electronic pen, an
electronic mouse, or a hand scanner. As shown in FIGURE
2, the system 2 includes six different entities, including
the electronic pen 10, electronic pen client 22, a control
10 node 24, a name server 26, a base translator 28, and an
application server 30. Although these various devices are
described and depicted separately, it is also possible to
combine two or more of the entities into the same device
(e.g., the electronic pen 10 and electronic pen client 22
15 can be contained in the same device).

The electronic pen 10 is responsible for detecting
positions on the address pattern, producing actions, and
sending information to the electronic pen client 22. In
addition to being able to leave pen markings, some
20 electronic pens can also have the ability to produce other
types of output, such as sound, vibration, or flashing
lights. The electronic pen 10 includes a memory for
storing a current grid, which comprises information

relating to an area of the address pattern that is near
the most recently detected position of the electronic pen
10. When the electronic pen 10 is loaded with the current
grid, it knows what actions to take based on the positions
5 that are read from the address pattern. When the
electronic pen 10 is first turned on or when it moves to
an area outside of the current grid, the electronic pen 10
must first request a new grid description before it can
continue processing information. In such a situation, the
10 electronic pen 10 requests a new grid description from the
electronic pen client 22.

The electronic pen client 22 can be located in a
mobile station 14, in a PDA, in a desktop or portable
computer, in the electronic pen 10 itself, in a server
15 somewhere on the Internet, or in another device. The
electronic pen client 22 serves as the center of
communications in the overall system 2. In particular,
the electronic pen client 22 receives new grid requests
and action requests from the electronic pen 10 and
20 responds to these requests by contacting an appropriate
entity within the overall system 2 to properly respond to
the request from the electronic pen 10. Furthermore, when
the electronic pen 10 is being used in connection with a

particular application, the electronic pen client 22 can store the application and/or any corresponding data received from the electronic pen 10 to facilitate processing and use of the application.

5 The name server 26 is used for translating a detected position on the address pattern into a Uniform Resource Location (URL) associated with that position. Different portions of the address pattern are assigned to different applications. Neither the electronic pen 10 nor the
10 electronic pen client 22, however, is aware of all of the different applications and the particular areas assigned to each application. Thus, when the electronic pen 10 detects a new or unknown position, it forwards the position information to the electronic pen client 22,
15 which in turn sends the information to the name server 26. The name server 26 then identifies an application associated with the received position and retrieves a URL where a description of the particular application can be found. The retrieved URL can then be used by the
20 electronic pen client 22 to retrieve the application description.

As an alternative, the name server 26 can comprise a global name server that keeps track of a location, in the

form of URLs to local name servers, where more information can be found about different addresses in the pattern. Similarly, each local name server can use other local name servers to obtain the necessary information, i.e., to
5 convert a position into a URL where an application description can be found. At the lowest level, the local electronic pen client should know all the paper addresses that are within a specific application or applications.

There are some services that should be available in
10 the overall system 2 for which it is inconvenient or not feasible to support such services in the electronic pen 10 or the electronic pen client 22. In such a case, the base translator 28 can be used to support the services. For example, the base translator 28 might contain handwriting
15 recognition software for converting pen actions into text or for converting pen actions into a predefined set of symbols. When such services are needed, the electronic pen client 22 can send a request to the base translator 28 along with the necessary data, and the base translator 28
20 can perform the requested service.

Another entity in the system 2 is a control node 24. The control node 24 is used for responding to actions in a standardized way. For example, the control node 24 can be

used to respond to certain generic functions, such as "cancel" or "submit" functions, in a consistent manner without regard to the particular application that is currently active.

5 In addition, the control node 24 is used for creating streaming-like applications. For instance, some applications might require that the positions on the address pattern that are detected by the electronic pen 10 be immediately sent, upon detection, to the electronic pen client 22 for use by the application (i.e., the electronic pen 10 does not wait to transmit the position data until a complete stroke is detected or until a "send" field is touched). One example is an application that is used to control an industrial robot in a warehouse. In such a case, the application description that is loaded onto the electronic pen server 22 can include instructions that all positions be streamed to a control node 24. As a result, the control node 24 can receive the positions in real time and can control the robot without waiting for the form (i.e., the current grid) to be completed. Thus, the control node 24 can perform a real-time translation from detected positions to a responsive action, such as moving

an object (e.g., a robot, a valve, etc.) or controlling a process.

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The application server 30 is a regular web or wireless application protocol (WAP) server that supports an application associated with a particular area of the address pattern. The application server 30 stores an application description and provides the application description to the electronic pen client 22 upon request. In addition, the application server 30 receives input data from the electronic pen 10 via the electronic pen client 22. For example, the application description might define a number of data entry areas on a form. Thus when data is entered on the form by the electronic pen 10, the data is received by the electronic pen client 22, converted into text using handwriting recognition software, and forwarded to the application server 30, which stores the data or otherwise processes the data in accordance with the function of the application.

Referring now to FIGURES 3 through 6 there are illustrated various examples of protocol stacks that can be used for communicating between the entities shown in FIGURE 2. Generally, however, such protocols apply however, only if the two communicating entities are

implemented in different devices. If two or more entities are combined into one device, a proprietary protocol can be used to communicate between the entities. FIGURE 3 illustrates the protocol stacks that can be used in the case of local communications (e.g., using Bluetooth) between the electronic pen 10 and the electronic pen client 22. If, on the other hand, the electronic pen 10 and the electronic pen client 22 communicate with one another via an Internet connection, the protocol stacks depicted in FIGURE 4 will be used. FIGURE 5 illustrates a protocol stack for communicating between the electronic pen client and each of the supporting entities, such as the name server 26, the control node 24, the base translator 28, and the application server 30, when the electronic pen client 22 is not contained within a server on the Internet (e.g., such as when the electronic pen client 22 is located in a mobile phone 14). Finally, FIGURE 6 depicts the protocol stacks that are used when the electronic pen client 22 is located on the Internet.

There are a number of procedures that can be used by the various entities in the system 2 to allow the system to operate properly. When the electronic pen 10 detects a position on the address pattern that is not within its

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currently loaded grid or when the electronic pen 10 has no
currently loaded grid, the electronic pen 10 initiates a
new grid procedure. The new grid procedure involves
sending a new grid request object to the electronic pen
5 client 22. The new grid request object contains the newly
detected position, a description of the actions that the
electronic pen 10 can natively support, and a description
of the output signals that the electronic pen 10 supports.
The reply to a new grid request object is a grid
10 description, which can be provided by the electronic pen
client 22 from its own internal memory or from the
information provided by an application server 30.
Generally, the electronic pen client 22 extracts the grid
description from an application description received from
15 the application server 30. The grid description should
only contain action-field-types that the electronic pen 10
has indicated that it natively supports, which means that
the electronic pen client 22 in some cases should convert
the extracted grid description into a format that the
20 electronic pen 10 can understand.

In some situations, it may be necessary for the
electronic pen 10 to unload its current grid at the
request of the electronic pen client 22. In such a case,

the electronic pen client 22 sends an empty grid
description to the electronic pen 10, thereby causing the
electronic pen 10 to unload its current grid. This can
occur, for example, when a particular application is
5 complete or when a new grid description request received
from the electronic pen 10 cannot be fulfilled, such as
when the position received from the electronic pen 10 is
not registered in the name server 26.

Another similar message is the empty grid description
10 with a grid exception. When the electronic pen 10
requests a new grid description from the electronic pen
client 22, the electronic pen client 22 uses the detected
position specified in the request to ask the name server
26 for a URL where the application description can be
15 found. If no URL is returned, the electronic pen client
22 can send an empty grid description with a grid
exception to the electronic pen 10. The grid exception
comprises a rectangle or other shape indicating the area
around the detected position where no registered
20 applications can be found. Preferably, the indicated area
is as large as possible so that the electronic pen 10
and/or electronic pen client 22 know the extent of the
surrounding area that is unassigned and do not have to

repeatedly send requests to the name server 26. Thus, the empty grid description with a grid exception causes the electronic pen 10 to unload its current grid and also informs the electronic pen 10 of an area surrounding the
5 detected position that can essentially be ignored because its is not associated with any application.

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The procedure that is used when the electronic pen 10 detects a new position is a find application description location procedure. This procedure is used by the
10 electronic pen client 22 to translate a detected position received from the electronic pen 10 into a URL where a description of an application corresponding to that position can be found. The procedure involves sending a request from the electronic pen client 22 to the name
15 server 26 containing identification of the detected position. The name server 26 responds by sending a reply to the electronic pen client 22 containing a URL where an application description can be found or, if the detected position is not registered in the name server 26,
20 containing an indication that no associated application is known to exist.

Once the electronic pen client 22 knows the URL where an application description can be found, the electronic

pen client 22 can initiate a get application description procedure, which allows the electronic pen client 22 to retrieve the application description from the application server 30. In particular, the electronic pen client 22
5 sends an application description request containing a unique ID for the requesting electronic pen 10 and/or electronic pen client 22 to the application server 30 located at the URL address provided by the name server 26. In response, the application server 30 provides an
10 application description object to the electronic pen client 22, which loads the application onto the electronic pen client 22. The application description object is similar to an HTML form with some additions and modifications.

15 Furthermore, the application description object can be sent from the application server 30 to the electronic pen client 22 in response to a submitted form (i.e., a submission of one completed form might automatically result in a new form being loaded onto the electronic pen
20 client 22). A related procedure is the application submit procedure, which is used by the electronic pen client 22 when the user of the electronic pen 10 selects a "submit" field in a form. In response to the selection of the

"submit" field, the electronic pen client 22 will submit the form content in accordance with instructions received in the application description. Typically, the electronic pen client 22 will submit the form content, in the same way as a regular web browser, to a URL specified in a form tag of the application description.

When an action that can be handled by the electronic pen 10 itself is generated, an action procedure is initiated by the electronic pen 10 to send an action request object to the electronic pen client 22. If the electronic pen client 22 cannot translate the action into a field value itself, the electronic pen client 22 further forwards the request to a base translator 28 for translating the action into a field value. In response to the action request object, an action reply object is sent from the electronic pen client 22 to the electronic pen 10. The action reply object contains output information that indicates to the electronic pen 10 which outputs signals to use. The output information, however, cannot be of type that the electronic pen 10 has previously indicated that it does not support. In some instances, the action reply object might contain a new grid description. In such a case the electronic pen 10 will unload its

current grid description and load the new grid description. Similarly, if the action reply object contains an empty grid description, the electronic pen 10 will simply unload its current grid description.

5 The action request object is also sometimes used to specify actions that should be processed by the control node 24. In this instance, the electronic pen client 22 initiates a control procedure by forwarding the received action to the appropriate control node 24. As a result,
10 the control node 24 sends an action reply object to the electronic pen client 22.

 The operation of the electronic pen 10 will now be discussed in greater detail. Each electronic pen 10 has a unique pen ID, which is sent to the application server 30
15 when an application description is requested. The electronic pen ID allows the application to identify the particular user that is using the application and to distinguish between multiple concurrent users of the same application, such as when different electronic pens 10 are
20 being used in connection with separate sheets of paper that each contain the same portion of the address pattern.

 Referring now to FIGURE 7, there is illustrated a block diagram of the electronic pen logic that handles

positions, strokes, actions, and grid descriptions for the electronic pen 10. The electronic pen 10 includes a control block 32 for controlling the operation of the electronic pen 10. A grid description block 34 represents
5 a memory location that stores a current grid description. At any given time, the electronic pen 10 can be in either of two modes. In a first mode, a grid description is loaded, while in a second mode, the grid description block 34 is not loaded with a current grid description.

10 As the electronic pen 10 moves across an address pattern, the electronic pen 10 periodically (e.g., every 1/100 of a second) detects a position by detecting all of the dots within, for example, a 3mm by 3mm area. Each detected position is forwarded (as indicated at 36) to a
15 position first in first out (FIFO) block 38, which acts as a buffer for temporarily storing the detected positions. The clocking of the position FIFO block 38 is controlled by the control block 32 (as indicated at 40).

The detected position is fed from the position FIFO
20 block 38 (as indicated at 42) to an in grid detector 44. The in grid detector 44 retrieves data from the grid description block 34 (as indicated at 46) and determines whether the received position is within the loaded grid

description. If not, the in grid detector 44 notifies the control block 32, which in turn initiates a request for a new grid. When the detected position is within the current grid, the position is then sent (as indicated at 50) from the in grid detector 44 to a stroke engine 52. The stroke engine 52 converts the received positions into strokes, which are then sent (as indicated at 54) to an action engine 56. A complete stroke is created when the electronic pen 10 is lifted from the paper or when it moves outside of the grid field where the stroke began. Finally, the action engine 56 converts the received stroke into an action that can be sent to the electronic pen client 22. By using grid action-field-types, the action engine knows which type of action to produce for a specific grid field.

Referring now to FIGURE 8, there is illustrated a block diagram of a state machine for the control block 32 shown in FIGURE 7. In this figure, events are indicated in capital letters, while tasks associated with the event are depicted in brackets. The process starts at step 60 with a start up event 62, which causes the position FIFO block 38 to begin receiving detected positions. Initially, the electronic pen 10 is in a no grid loaded

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addition, the FIFO block 38 resumes operation and the control block 32 moves into the no grid loaded state 64.

When the control block 32 is in the grid loaded state 72, a current grid is loaded in the grid description block 34. While the control block 32 remains in this state 72, the position FIFO block 38 continues to receive detected positions and passes them on to the stroke engine 52 and action engine 56. Actions produced by the action engine 56 are sent (as indicated at 58) to the electronic pen client 22 (i.e., in accordance with the action procedure described above).

At some point, an outside grid indication 74 may be received by the control block 32 from the in grid detector 44. The outside grid event 74 causes the FIFO block 38 to stop generating new positions. In addition, the electronic pen 10 enters a flushing stroke and action state 76 wherein the strokes that are currently in the stroke engine 52 and the actions that are currently in the action engine 56 are flushed to the electronic pen client 22. Once the stroke engine 52 and action engine 56 have been fully flushed (as indicated at 78), the electronic pen 10 sends a request for a new grid to the electronic pen client 22 and unloads the current grid. The control

block 32 then moves back into the waiting for grid state
68.

As a general matter, the electronic pen 10 may be
capable of supporting various different types of output,
5 including audio, such as warning tones; visual, such as a
flashing light; tactile, such as vibration; and/or ink. In
some cases, it might be desirable to allow the user of the
electronic pen 10 to turn off the ink of the pen 10, such
as when the electronic pen is being used on a portion of
10 the address pattern that is public or shared or when the
user wants to be able to reuse the current sheet of paper.

The electronic pen client 22 will now be described in
greater detail. Generally, the electronic pen client 22
is analogous to a regular web browser. It is responsible
15 for loading applications from application servers 30 and
for handling input from the electronic pen 10.

Preferably, the electronic pen client 22 is located in a
separate device from the electronic pen 10 itself. This
is because it is desirable to minimize the size and power
20 supply requirements of the electronic pen 10, which will
likely be adversely affected by the processing resources
and memory necessary to support the functions of the
electronic pen client 22.

Referring now to FIGURE 9, there is illustrated a block diagram of a state machine for the electronic pen client 22. Initially, the electronic pen client 22 is in a no application loaded state 80. The electronic pen client 22 recognizes only one signal when in this state 80, namely a new grid request from the electronic pen 10. Such a request causes a load grid indication event 82. The electronic pen client 22 responds by sending a request to the name server 26 to translate a position contained within the new grid request into a URL where the application description can be found (i.e., in accordance with the find application location procedure). Next, the electronic pen client 22 enters a waiting for application description URL state 84. If no URL for the application description can be found (as indicated at 86), the electronic pen client 22 sends a new grid reply to the electronic pen 10, wherein the reply contains an empty grid description with a grid exception. As a result, the electronic pen client 22 returns to the no application loaded state 80.

If a URL for the application description is received from the name server 26 (as indicated at 88), the electronic pen client 22 sends a request to the

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handle itself, in which case the electronic pen client 22 will send the action to the base translator 28 (as indicated at 98). The electronic pen client 22 then moves into a waiting for response from the base translator state 100. Once a base translator response 102 is received by the electronic pen client 22, the electronic pen client 22 updates a current form or other data associated with the currently loaded application and sends an action reply to the electronic pen 10 with appropriate output information.

Another type of action that the electronic pen client 22 can receive from the electronic pen 10 is a request that should be forwarded to a control node 24. In such a case, the action is sent to a control URL specified in the application description (as indicated at 104), and the electronic pen client 22 enters a waiting for response from the control state 106. Once a response is received from the control (as indicated at 108), the electronic pen client 22 sends an action reply to the electronic pen 10 with appropriate output information.

A third type of action is a submit form request, in response to which the electronic pen client 22 will submit the current form to the application server 30 that is identified by the URL in the application description (as

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indicated at 110). The electronic pen client 22 then enters a waiting for response from the application server state 112. If the application server 30 responds by sending an empty application description to the electronic pen client 22 (as indicated at 114), the current application is unloaded from the electronic pen client 22 and an action reply is sent to the electronic pen 10 with an empty grid. As a result, the electronic pen client 22 returns to the no application loaded state 80. On the other hand, if the application server 30 responds with a non-empty application description, the old application is unloaded from the electronic pen client 22, the new application description is parsed and loaded in the electronic pen client 22, an action reply is sent to the electronic pen 10 with a new grid description and with appropriate output information, and finally the electronic pen client 22 returns to the application loaded state 96.

A fourth type of action that can be received by the electronic pen client 22 from the electronic pen 10 is a request to load a new grid. This action occurs, for example, when a position outside of the current grid is detected by the electronic pen 10. When a new grid request is received, the electronic pen client 22 sends a

request to the name server 26 (as indicated at 116) and the electronic pen client 22 returns to the waiting for application description URL state 84.

Finally, a fifth type of action that can be received
5 by the electronic pen client 22 is an action that the electronic pen client 22 can handle itself, in which case the electronic pen client 22 updates the current form and sends an action reply to the electronic pen 10 with appropriate output information (as indicated at 118). The
10 electronic pen client 22 then remains in the application loaded state 96. One type of action that the electronic pen client 22 might be able to handle itself is a local application. For example, the electronic pen client 22 might be capable of performing certain basic functions
15 that are defined by a local application. Thus, when the electronic pen client 22 receives a new grid request, the position associated with the new grid request can be analyzed to determine if it corresponds to a local application. If so, the electronic pen client 22 can load
20 the application description from its local memory, send a new grid description to the electronic pen 10 without having to communicate with the name server 26 or the application server 30.

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Another action that might be handled locally by the electronic pen client 22 relates to the selection of fields within a form. When the electronic pen client 22 receives an action, the field that corresponds to that action receives focus. When this occurs, the electronic pen client 22 might display the field's value on its display or output the value by audio. In addition, the electronic pen client 22 might allow the user to edit the value of the field by means other than the electronic pen 10. Yet another type of action that might be handled by the electronic pen client 22 itself are actions that relate to a clipboard function. When a "copy" field is selected, the value of the field that had focus at the time the copy field was selected is transferred to the clipboard. Similarly, when a "paste" field is selected, the value stored in the clipboard is transferred to the field that had focus at the time the paste field was selected.

Referring now to FIGURES 10A through 10C, there is shown, by way of example, a message flow and signaling diagram illustrating the operation of the electronic pen system 2 depicted in and discussed in connection with FIGURE 2. Initially, the electronic pen 10 detects a

first position on the address pattern at step 120 (e.g.,
at a location on a sheet of paper designated for composing
and sending emails). At this stage, it is assumed that
the electronic pen 10 is in a no grid loaded state. Thus,
5 in response to the detection of the first position, the
electronic pen 10 sends a new grid request 122, which
contains the detected position information, to the
electronic pen client 22. As a result, the electronic pen
client 22 sends an application location request 124
10 containing the detected position information to the name
server 26, at step 126. The name server 26 translates the
detected position into a URL where an application
description that corresponds to the detected position can
be found (e.g., a URL address for a server containing an
15 email application), and returns an application location
reply 128 containing the retrieved URL to the electronic
pen client 22.

The electronic pen client 22 then sends an
application description request 130, which contains the
20 unique pen ID for the electronic pen 10, to the
application server 30. The application server 30
retrieves the application description at step 132 and
sends an application description reply 134 containing the

retrieved application description to the electronic pen client 22. The electronic pen client 22 then parses and stores the application description at step 136. This step further involves generating a current grid description from the application description and sending the grid description to the electronic pen 10 in a new grid reply 138. The electronic pen 10 stores the received grid description at step 140 and resumes processing of the detected positions. Using the detected positions and the information in the grid description (e.g., so that the electronic pen 10 knows which fields of the email form are being filled in), the electronic pen 10 generates strokes at step 142 and generates actions at step 144 using the stroke engine 52 and action engine 56 shown in FIGURE 7.

Each time an action is generated that cannot be handled by the electronic pen 10 itself, an action request 146 containing a description of the action is sent from the electronic pen 10 to the electronic pen client 22. At this point, the electronic pen client 22 should determine what type of action has been received so that it can respond to the action in an appropriate manner. First, it is determined whether the action requires the attention of, or otherwise should be processed in accordance with, a

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local application at step 148. Very basic applications or frequently used applications (e.g., delete entered text), for example, might be stored locally to avoid having to contact another entity. In such a case, the electronic pen client 22 retrieves the local application at step 150 and sends an action reply 152, which can contain a new grid description or other appropriate information.

However, if it is determined at step 148 that the received action does not relate to a local application, the process continues at step 154 where it is determined whether the received action requires processing by an external translator (e.g., handwriting recognition). If so, an action request 156 containing a description of the action is sent by the electronic pen client 22 to the base translator 28. The base translator 28 processes the action at step 158 and sends an action reply 160 containing output information responsive to the received action (e.g., text corresponding to written characters) to the electronic pen client 22, which can forward the output information to the electronic pen 10 in an action reply 162, if necessary.

If it is determined at step 154 that the received action does not require processing by an external

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translator, it is next determined whether the action relates to a control application at step 164. If so, an action request 166 containing a description of the action is sent by the electronic pen client 22 to the control server 24. The control server 24 processes the received action at step 168 and, if a response is necessary, returns output information responsive to the received action in an action reply 170, which is forwarded from the electronic pen client 22 to the electronic pen 10 in an action reply 172.

Assuming that it is determined at step 164 that the received action does not relate to a control function, it is next determined whether the action comprises a request to submit a form at step 174 (e.g., a selection of a "send" area on the email form). If so, an action request 176 containing the data entered onto the form is sent by the electronic pen client 22 to the application server 30. The application server 30 processes the form at step 178 and sends an action reply 180 containing a new application description (or an empty application description) to the electronic pen client 22. The electronic pen client 22 parses and stores the new application description at step 182 and generates a new grid description from the newly

received application description. The electronic pen client 22 then sends an action reply 184 containing the new grid description. Although not illustrated in the figure, the electronic pen 10 will typically respond to the receipt of a new grid description by unloading its current grid description and loading the new grid description into its memory.

At some point, it is assumed that the electronic pen 10 detects a position that is outside of the currently loaded grid at step 186. In response to such an event, the electronic pen 10 sends a new grid request 188 containing the newly detected position data to the electronic pen client 22. In response, the electronic pen client 22 again generates an application location request 190 containing the detected position data and sends the request to the name server 26. The name server 26 determines whether a URL for an application description that corresponds to the newly detected position is available at step 192.

If so, the name server 26 sends an application location reply 194 containing a retrieved URL to the electronic pen client 22, which in turn sends an application description request 196 containing the unique

pen ID for the electronic pen 10 to the application server
30 at the identified URL address, just as previously
discussed in connection with messages 128 and 130. In
this case, however, it is assumed that the application
5 server 30 determines that the requested application
description is unavailable at step 198. As a result, the
application server 30 sends an application description
reply to the electronic pen client 22 containing an empty
application description. In response to the receipt of an
10 empty application description, the electronic pen client
22 unloads the current application at step 202 and sends a
new grid reply 204 containing an empty grid description to
the electronic pen 10. The electronic pen 10 responds to
the receipt of the empty grid description by unloading the
15 current grid description at step 206.

Another possibility is that the name server 26
determines at step 192 that a URL corresponding to the
detected position is not available. In this situation,
the name server 26 sends an application location reply 208
20 to the electronic pen client 22. The reply 208 may simply
be empty to indicate that a URL is not available.
Preferably, however, the reply 208 contains a grid
exception defining the largest area possible around the

detected position for which there is no corresponding URL.
In response to the reply 208, the electronic pen client 22
sends a new grid reply 210 containing an empty grid
description with a grid exception. Upon receiving the
5 reply 210, the electronic pen 10 unloads the current grid
description at step 212. Furthermore, assuming that the
electronic pen 10 receives and recognizes the grid
exception information, the electronic pen 10 may
subsequently be able to determine that certain detected
10 positions on the address pattern are not associated with
any application without having to send a request to the
name server 26 or the application server 30.

In addition to being able to detect movements of the
electronic pen 10 (e.g., for purposes of inputting
15 handwritten text or drawings), it may also be desirable in
some cases to use the electronic pen 10 or a similar
device, such as an electronic hand scanner, to scan
information previously printed on a specially formatted
surface. Such scanned information could be stored in the
20 electronic pen 10 and/or transmitted to the electronic pen
client 22 for storage or for processing in accordance, for
example, with an application description retrieved from
the application server 30.

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To facilitate scanning, information to be scanned should be printed or drawn on a surface that includes a preprinted address pattern. The information can include, for example, a painting, typed characters, handwritten or printed drawings or images, and/or handwritten text on the addressed paper sheet. To enable the address pattern to be distinguished from the printed information, the address pattern is of a different type of color than is used for the printed information. Preferably, the printed information uses colors that are within the visible light spectrum, while the address pattern uses a different portion of the visible light spectrum or is printed within either the ultraviolet spectrum or infrared spectrum. An electronic hand scanner can then simultaneously read the printed information and the underlying address pattern by detecting reflected light in two different spectra.

Referring now to FIGURE 11, there is illustrated a preferred embodiment of an electronic hand scanner 220 for scanning printed information in accordance with the present invention. The electronic hand scanner 220 is capable of simultaneously detecting two layers 222 and 224 of a specially formatted surface 226. The formatted surface can include, for example, a sheet of paper, or a

display screen for displaying images or other information,
wherein the address pattern is preprinted on the display
screen or is generated on the display screen as background
to a displayed image. The first layer 222 of the
5 formatted surface 226 includes the printed information and
the second layer 224 includes the preprinted address
pattern 228.

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The printed information is shown as text in this
example for ease of illustration. However, as mentioned
10 above, the printed information can be of any type and on
virtually any type of surface. Although the two layers
222 and 224 are shown separately, it will be understood
that the information printed on each layer 222 and 224 can
be included on the same surface 226. In addition,
15 although the printed information layer 222 is depicted as
overlying the address pattern layer 224, it will be
understood that the printed information can be printed on
a surface that is pre-formatted with the address pattern
228 or that the address pattern can be superimposed over
20 preexisting printed information. The electronic hand
scanner 220 includes a light emitting element 230 for
illuminating the formatted surface 226 and a reading
sensor 232 for detecting both the printed information

layer 222 (as indicated at 236) and the address pattern
layer 224 (as indicated at 234).

5 In one embodiment of the invention, the light
emitting element 230 illuminates the surface 226 with a
broad spectrum light. The reading sensor 232 includes a
plurality of sensing pixels wherein a filter is placed
over every other sensing pixel. In this embodiment, it is
assumed that the printed information layer 222 is printed
using an ink that will reflect only a portion of the light
10 spectrum (e.g., visible light or a portion thereof). The
address pattern layer 224, on the other hand, is printed
using an ink that reflects a second portion of the light
spectrum, which differs from the first portion of the
light spectrum used for the printed information layer 222.
15 The filter that is placed over every other sensing pixel
then filters light reflected by the printed information
layer 222 and enables sensing of the address pattern 228.
Thus, sensing pixels with a filter generate address layer
images, while pixels without a filter generate printed
20 information layer images. As a result, the printed
information does not interfere with the detection of the
address pattern 228 (and vice versa).

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Each pixel of printed information can be associated with a particular portion of the address pattern 228 so that a precise location of each pixel of printed information can be determined. For example, by forwarding the detected printed information and the corresponding portion of the address pattern to a processor 238 in the electronic hand scanner 220 or in another device, the processor 238 can map information detected from the printed information layer 222 onto the address pattern 228. More particularly, the processor 238 uses software to map the detected printed information onto an electronically stored copy of the address pattern 228 using the detected portions of the address pattern that are associated with the detected printed information. In a second embodiment of the invention, the light emitting element 230 includes two types of light emitting diodes (LEDs). The first type of LED emits infrared light, while the second type of LED emits non-infrared light, preferably visible light. The LEDs are then switched on and off at half the sensor rate or, alternatively, the sensor rate is doubled and the two types of LEDs are turned on in alternating sensing intervals. Images sensed by the reading sensor 232 under infrared light then

contain the address layer, while images sensed by the reading sensor 232 under visible light show the printed information layer 222.

5 In either of these embodiments, when the electronic hand scanner 220 is moved across the surface 226, the processor 238 can reconstruct the printed information precisely. Because each pixel of printed information can be associated with a unique portion of the address pattern 228, the scanned information can be reconstructed
10 precisely regardless of how many times or in which direction the electronic hand scanner 220 is moved or rubbed across the surface. If only parts of the image are scanned, the exact distance between the scanned areas can be determined. Special applications can be created for
15 use in generating an electronic copy of a picture, text, musical notes, or any other printed information, and the processor 238 can output the scanned information in the form of sound, text, or images.

20 Although various preferred embodiments of the method and apparatus of the present invention have been illustrated in the accompanying Drawings and described in the foregoing Detailed Description, it is understood that the invention is not limited to the embodiments disclosed,

but is capable of numerous rearrangements, modifications,
and substitutions without departing from the spirit of the
invention as set forth and defined by the following
claims. Furthermore, it shall be understood that the
5 terms "comprises" and "comprising," when used in the
foregoing Detailed Description and the following claims,
specifies the presence of stated features, elements,
steps, or components but does not preclude the presence or
addition of one or more other features, elements, steps,
10 components, or groups thereof.

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